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Nigerian Journal of Genetics 28 (2014) 48–51

http://www.ajol.info/index.php/njg

Short communication

Assessment of variability of finger millet (*Eleusine coracana* (L) Gaertn) landraces germplasm in Northern Nigeria

I.D. Umar [a,*], E.H. Kwon-Ndung [b]

[a] *Department of Biological Science, University of Abuja, Abuja, Nigeria*
[b] *Department of Biological Science, Federal University Lafia, Lafia, Nigeria*

Available online 9 October 2015

Abstract

Germplasm identification and characterization is an important link between conservation and utilization of plant genetic resources. The present study was conducted to characterize the morphological diversity of 10 germplasm accessions of Finger millet (*Eleusine coracana* (L) Gaertn) collected from diverse locations spread across the geographic Northern Nigeria during the 2008, 2009 and 2010 cropping seasons. The seeds of the accessions were planted in a randomized complete block design (RCBD) with three replications in each of two locations-Keffi and Gwagwalada, during the three cropping seasons. The field studies for the three seasons in the two locations followed uniform agricultural practices. Field data was collected on morphological traits such as plant height, leaf length, leaf diameter, finger length, finger width, number of fingers and 1000 seed weight were recorded in accordance with standard finger millet descriptors. The results obtained, showed that plant height in accession Ex-Kwi was significantly different from all the other nine accessions while the highest leaf length which was recorded in Ex-Riyom was significantly different ($p < 0.05$) from only accession Ex-Dantse. Similarly, significant variations were observed in the number and length of fingers, and 1000 seed weight across all the accessions tested, over the three cropping seasons in the multilocational trial. Evaluation of phenotypic and genotypic characters of the different accessions revealed that the genotypes expressed significant genetic diversity for plant height, 1000 seed weight, leaf length and number of tillers than all the other traits assessed at $p < 0.05$ level of significance. These results tend to suggest a high variability existing among the selected morphological traits. Specifically, 87% of the variations were explained by the ANOVA model leaving only 13% unexplained. The cluster analysis based on morphological traits revealed six major distinct groups with one landrace forming independent cluster for the pooled analysis for the three years.

Keywords: Germplasm; Assessment; Finger millet; Northern Nigeria

1. Introduction

In Nigeria, the finger millet plant is diverse and is popularly used without restriction in our different multi-ethnic, multi-cultural and multi-religious groups. In various areas it is referred to as tamba i(Nigeria), Ragi (India), Mandua Winbi (Swahili) bulo (Uganda), kurakan (Sri Lanka), fingerhirse (German). Epidemiological evidence showed that the plant is widespread and well adopted to diverse regions of the world. In East Africa, the plant is known to originate from Ethiopia and then spread to Southern African countries such as Namibia and Botswana. The plant is also well grown in Asian countries such as India and China, Middle East [11].

Germplasm identification in finger millet plant is an important link between conservation and utilization of plant genetic resources. The usefulness of germplasm in the study of plant genetic resources could play an important role in the generation of new hybrids and high yielding crop varieties with disease resistant traits to cope with adverse challenges associated with biotic and abiotic stress, [12].

The problem of erosion of genetic diversity of finger millet plant in Nigeria as a result of large-scale farming activities,

* Corresponding author.
E-mail address: idumaru2013@gmail.com (I.D. Umar).
Peer review under responsibility of The Genetics Society of Nigeria.

http://dx.doi.org/10.1016/j.nigjg.2015.09.005

urbanization and preferential land uses causes leaching, and may destroy our natural vegetation which eventually erodes finger millet beyond the reach of rural farmers [2]. The phenotypic characterization could reveal the genetic relatedness within these species. This will be useful in the conservation of new species and understanding of the genetic diversity. This may provide information on the plant taxonomy as well as ecology of the plant.

2. Methodology

2.1. Sampling methods

Field survey was conducted between November 2007 and February 2008. The 10 finger millet (seeds) were randomly collected from local farmers in consultation with the Agricultural Development Programme (ADP) in five states (Bauchi, Gombe, Nasarawa, Plateau and Kaduna) and the Federal Capital Territory (FCT) Abuja, Nigeria.

3. Experimental design

The randomized complete block design (RCBD) was used to plant the finger millet seeds in the three cropping seasons in 2008, 2009 and 2010 in accordance with standard agricultural practices. Each plot consisted of 2 m × 3 m (6 m^2). Plant to plant spacing was maintained at 10 cm in both locations. A basal dose of NPK was applied 4 weeks after planting in both locations. Fertilizer was applied at 100 kg N (Nitrogen) 60 kg K_2O (Potassium) and 40 kg, P_2O_5 (Phosphorus) in both locations. Weeding was done at six weeks after planting in both locations. This field experiment was repeated in the two locations in the 2009 and 2010 cropping seasons and data collected for all the seasons.

4. Phenotypic characterisation

Morphological traits such as plant height, plant width, leaf length, leaf width, number of fingers, finger length and finger width were determined and recorded in accordance with standard finger millet descriptors [4]. The number of days to flowering was recorded for each plot as a whole and the remaining characters were recorded on 10 randomly chosen plants per plot. The number of fingers per panicle and number of productive tillers per plant were recorded. Mature panicles or fingers were harvested, sundried and weighed to record panicle yield, and then threshed to measure grain yield. This experiment was repeated in the 2009 and 2010 cropping seasons in both locations using the same treatments and conditions.

5. Results

5.1. Morphological traits of finger millet

Table 1 shows the pooled means of morphological traits of finger millet accessions planted in Northern Nigeria for the three cropping seasons (i.e. 2008, 2009 and 2010). Plant height varied from 54.66 cm in Ex-Dantse to 64.96 cm in Ex-Biliri with a mean value of 59.79 cm across the ten accessions. Plant girth varied from 9.77 cm in Ex-Andaha to 12.30 cm in Ex-Tafawa Balewa with a mean of 11.07 cm across all the accessions. Leaf length varied from 49.02 cm in Ex-Dantse to 58.20 cm in Ex-Riyom with a mean of 53.53 cm across the ten accessions. Leaf width varied from 1.30 cm in Ex-Tafawa Balewa to 1.94 cm in Ex-Kwi with a mean of 1.51 cm across all the accessions. Number of fingers varied from 73.5 in Ex-Dantse to 171.5 cm in Ex-Kwi with a mean of 105.1 across the ten accessions. Finger length varied from 44.90 cm in Ex-Gwagwalada to 99.25 cm in Ex-Andaha with a mean of 64.80 cm across the ten accessions while the finger width ranged from 2.1 cm in Ex-Gura to 2.7 cm in Ex-Riyom with a mean of 2.39 cm across all the accessions. Number of ears varied from 16.5 in Ex-Gwagwalada to 25.5 in Ex-Kwi with a mean value of 20.15 across the accessions while 1000 seed weight varied from 150.9 g in Ex-Gwagwalada to 275 g in Ex-Andaha with a mean value of 200.09 g across the ten accessions.

At the end of the three cropping seasons, the lowest similarity was observed between Ex-Biliri and Ex-Dantse (Fig. 1). The dendogram showed the highest genetic similarity between the germplasms Ex-Biliri, Ex-Bum and Ex-Dantse. The population is divided into two germplasm viz: a smaller subgroup comprising of Ex-Kwi and Ex-Andaha. The other subgroup contains the rest of the germplasm. This group consist of Ex-Gwagwalada and Ex-Gura; Ex-Tafawa Balewa and EX-Kwakwi; Ex-Riyom, Ex-Bum, Ex-Biliri and Ex-Dantse. Close relatedness was observed between Ex-Riyom, Ex-Bum Ex-Biliri and Ex-Dantse. Maximum closeness was observed between Ex-Dantse and Ex-Riyom. Ex-Tafawa Balewa and Ex-Kwakwi taking from two different places fall under the same group (Fig. 1). It is clear that.

Ex-Tafawa Balewa, Ex-Kwakwi, Ex-Riyom, Ex-Bum, Ex-Biliri and Ex-Dantse can be said to constitute a group where the morphological differences amongst them are narrow or close.

6. Discussion

Analysis of 10 finger millet landraces using 9 morphological traits (Plant height, plant girth, leaf length, leaf width, Number of fingers, length of fingers, width of fingers, Number of matured ears and 1000 seed weight), showed significant variations among the landraces in the three cropping seasons (2008, 2009 and 2010 respectively) as indicated in this trials. Our results showed that plant height across the ten accessions was highest in accession Ex-Biliri (64.96 cm), and this was significantly different ($p < 0.05$), from those of the other nine accessions. Also accessions Ex-Riyom, Ex-Bum, Ex-Kwakwi, Ex-Tafawa Balewa and Ex-Kwi were significantly different ($p < 0.05$) from Ex-Dantse in terms of plant height, this showed that plant height across the ten accessions varied significantly ($p > 0.05$). Plant girth, leaf width, number of tillers and number of fingers showed significant variations

Table 1
Pooled Means of Morphological traits of finger millet Accessions grown in Northern Nigeria, for three cropping seasons (2008, 2009 and 2010).

Accession	Plant height (cm)	Plant girth (cm)	Leaf length (cm)	Leaf width (cm)	Number of fingers	Finger length (cm)	Finger width (cm)	Number of ears	Seed weight (1000)g
Ex-Dantse	54.66	10.68	49.02	1.43	73.50	61.30	2.60	20.00	175.70
Ex-Riyom	60.33	12.00	58.20	1.45	79.50	79.35	2.70	19.50	185.75
Ex-Bum	56.33	11.06	55.36	1.38	81.50	60.95	2.20	21.50	190.75
Ex-Gura	59.16	11.52	50.96	1.67	132.00	64.65	2.10	19.00	183.40
Ex-Kwakwi	58.28	10.42	55	1.57	115.50	61.15	2.30	20.00	210.95
Ex-Tafawa Balewa	59.05	12.30	54.29	1.30	102.50	51.65	2.20	21.00	200.80
Ex-Biliri	64.96	11.78	54.32	1.38	77.50	54.00	2.40	19.00	180.90
Ex-Gwagwalada	60.47	10.15	53.16	1.50	85.00	44.90	2.60	16.50	150.90
Ex-Andaha	58.26	9.77	50.24	1.57	132.50	99.25	2.30	22.50	275.85
Ex-Kwi	62.50	11.39	54.15	1.94	171.50	70.90	2.50	25.50	245.75
TOTAL	567.9	110.74	535.3	15.50	1051.00	648.10	23.90	201.50	2000.0
MEAN	59.79	11.07	53.53	1.51	105.10	64.80	2.39	20.15	200.09
LSD(0.05)	6.48	0.48	7.61	0.184	13.61	7.77	0.09	2.69	32.54
CV (%)	11.54	6.85	6.05	3.064	4.63	0.77	0.08	1.69	16.55

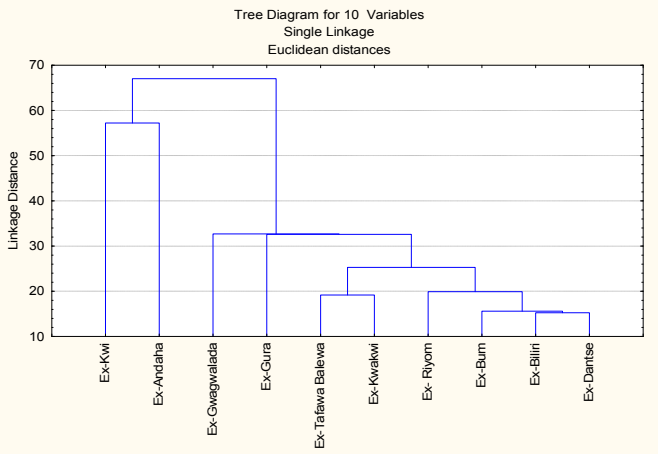

Fig. 1. Dendrogram of morphological characters showing the linkages among ten accessions of finger millet grown in Northern Nigeria for 2008, 2009 and 2010 cropping seasons.

Table 2
Range of variation for important morphological characters in finger millet accessions grown in Keffi and Gwagwalada, Northern Nigeria, for the 3 cropping seasons (2008, 2009 and 2010).

Parameter	Min	Max	Mean	Variance
Time to flower (days)	60	120	97.67	11.43
Plant height (cm)	54.66	64.96	59.67 ± 3.38	6.85
Plant girth (cm)	9.77	12.30	11.07 ± 0.32	6.08
Leaf length (cm)	49.00	55.30	53.50 ± 3.37	6.05
Leaf diameter(cm)	1.30	1.94	1.51 ± 0.11	3.06
Number of fingers	73.50	171.5	105.1 ± 3.97	4.63
Length of fingers (cm)	44.90	99.25	64.80 ± 5.26	0.77
Finger diameter (cm)	2.1	2.7	2.39 ± 0.07	0.08
Number of ears	16.5	25.5	20.15 ± 1.88	1.69
1000 seed weight (g)	150.9	275.85	200.09 ± 3.38	16.55

across the ten accessions in the three cropping seasons. Plant width was also observed to vary as the widest diameter of 0.44 cm was recorded in Ex-Kwakwi, and Ex-Andaha this showed significant difference, ($p > 0.05$), from accessions Ex-Dantse, Ex-Riyom, and Ex-Tafawa Balewa (see Table 1). Leaf width also showed significant variations across the ten accessions with Ex-Kwi having the widest leaf width of 1.94 cm compared with 1.30 cm in Ex-Tafawa Balewa. Others that exhibit variations in this morphological characters include Ex-Dantse and Ex-Bum, Ex-Kwakwi and Ex-Tafawa Balewa, Ex-Gwagwalada and Ex-Biliri. The highest number of tillers of 40 was recorded in Ex-Dantse and was significantly different from all the others except Ex-Tafawa Balewa and Ex-Gwagwalada which produced 30 each. The greatest number of fingers of 259 was achieved in Ex-Kwi. Similarly, finger millet trait variations were also observed by Upadhyaya et al. [10]; and Mnyenyembe and Gupta, [8]. Evaluation of phenotypic and genotypic character for the different accessions shows that the genotypes had more genetic diversity for plant height, 1000 seed weight, leaf length and tillers than all the other traits assessed in this trials. Table 2 showed the range of variability existing in the ten accessions used in this trials. Shahryari et al. [9], Garavandi and Kabrizi [3] established genetic diversity for plant height, 1000 seed weight, spikelet in bread wheat genotypes and similar crops. Kempana and Thirumalachar [6] and Abraham et al. [1] found significant variation for grain yield and number of productive tillers per plant. Josh and Mehra [5] reported significant variation for days to flowering, plant height, finger length, number of fingers in finger millet accessions. Upadhyaya et al. [10] reported large phenotypic diversity in pearl millet germplasm especially in terms of days to flowering, plant height, total tillers and 1000-seed weight which was also observed in this work (see Table 2). For instance, during the three year trials in both Keffi and Gwagwalada locations, there were accessions that could flower as early as 60 days and others as late as 120 days. Similarly, variations were observed in plant diameter, leaf length, number of fingers, number of ears and 1000 seed weight. This exhibition of significant genetic diversity observed in this report agrees with the work of Garavandi and Kabrizi [3] and Shahryari, et al. [9] who reported genetic diversity for plant height, 1000 seed weight, seed number and spikelet in bread wheat genotypes.

From the dendrogram in Fig. 1, the landraces Ex-Dantse, Ex-Biliri, Ex-Bum and Ex-Riyom are closely related in all the morphological characters recorded in this trials,in the three cropping seasons put together, as they are grouped together to form the first cluster, while Ex-Kwakwi and Ex-Tafawa Balewa form the next group. This indicates a significant level of close relatedness among these accessions. While Ex-Gwagwalada and Ex-Gura are closely related, Ex-Andaha and Ex-Kwi have a very wide distance and are grouped separately from all other accessions. McCune and Grace [7]; used similarity of characters to identify cluster groups, this was also applied in this trials to identify cluster groups). There is slight variation in leaf length only in Ex-Dantse as all the others exhibit little or no variation while Ex-Kwi and Ex-Gura exhibited significant variation in leaf diameter compared to the other 8 accessions. The highest number of fingers where produced by Ex-Kwakwi, Ex-Gura, Ex-Tafawa Balewa, Ex-Andaha and Ex-Kwi in the three cropping seasons while the least number of fingers was produced by Ex-Dantse Ex-Riyom and Ex-Biliri. They also produced seeds with the highest 1000 seed weight (Table 1). This was in agreement with [10] report on Pearl millet germplasm.

7. Conclusion

The objectives of our research have been greatly achieved. We were able to demonstrate the morphological traits of finger millet and also to determine the phylogenetic diversity of the plant using cluster analysis. These results have clearly established the possibility of genetic variation and could be useful at ascertaining evolutionay diversion whenever mutation occurs. Further studies should involve the identification of specific primers which could identify loci responsible for this diversity.

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